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SCHOOL NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XIII BROOKLYN, N. Y., APRIL 29, 1925 NOS. 1—3

SORGHUM*

The cereals, as wheat, rice, corn, and rye constitute the basic food of most of the world's human population. Although sorghum occupies a minor place among these crops, yet for centuries it has been a staple food plant of certain sections of the Old World. The inhabitants of the Bombay and Madras Presidencies of India, of northern China, Manchuria and Chosen, of western Asia (including Syria, Turkestan and Mesopotamia), and of parts of Africa have depended largely upon this cereal for human, as well as animal, sustenance.

CULTIVATION IN THE OLD WORLD

Northern China and Manchuria.—Quite diverse kinds of sorghum are grown in the different regions of the world. In northern China and Manchuria a special group, the *kaoliang*, is extensively cultivated. The number of varieties is very great, so that it is possible to find in a single field thirty or forty different kinds which differ in height, time of maturing, color of seed, and other characters. The grain constitutes the main food of the people, the light colored varieties being the principal ones used for grinding into flour and making cakes. The varieties with dark colored grains are less desirable for human food and are used as feed for the farm animals, taking the place held in other countries by oats. The grain is also used for distilling the fiery spirit called "Samshu" so common in North China. The heads, after the removal of the seed, are utilized either for fuel or for the manufacture of brooms—some varieties being better adapted for the latter purpose than others. Also the stalks are used for fuel, for making baskets and mats, for building houses and fences and as poles for beans, cucumbers and yams. Even the roots are dug up and used for fuel.

India.—Sorghum, or *jowar*, as it is commonly called, ranks third among the cultivated crops of India: approximately 25 million acres are grown annually. The crop is first in importance in the Bombay Presidency, where more than one-third of the total area (approximately 8 million acres) devoted to the cultivation of grains is sown to sorghum. Two distinct types of sorghum crops are grown here: the summer crop, or *Kharif* jowar, sown in the spring and

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*This *Leaflet* has been prepared to accompany an educational exhibit of the types of sorghum, prepared by the Brooklyn Botanic Garden for the High Schools.

harvested in the fall; and the *Rabi* crop, or winter jowar, sown in September or October and harvested in the following February or March. Different varieties are utilized in the plantings of Kharif and Rabi jowar. Throughout India, the grain of the sorghums is used very largely for human consumption, and the number of varieties grown is very large.

Africa.—Sorghums are widely distributed in Africa and are the staple cereal crop of a large proportion of the native population. The grain is used for human food and for the manufacture of fermented drink. Certain types are extensively cultivated in Egypt and in the Barbary states of Northern Africa. In South Africa quite different varieties, usually spoken of as *kafir* corn, are found.

Europe.—*Broom* corn has been cultivated in Italy for about 300 years, and today is an important agricultural product in Italy and Hungary. With the exception of broom corn, sorghums have not been extensively grown in Europe, although in the Mediterranean countries some varieties are grown, the seed being used for poultry and stock feed. To a minor extent the grain is also used by the poorer classes in making bread.

INTRODUCTION INTO THE NEW WORLD

West Indies.—The sorghums were introduced early into the West Indies from Africa. In Jamaica a variety known as "*Guinea* corn" is grown rather extensively. In Haiti several closely related varieties are grown under the general name of "Petit Mil." The grain is extensively used for human food, as well as for feed for animals.

United States.—Broom corn was apparently the first sorghum to be introduced into the United States, which occurred as early as 1798. During the early part of the last century it was grown more or less widely over the eastern part of the country, but in recent years its production has proceeded westward, and at the present time most of the crop is grown in Illinois, Oklahoma, and adjacent states. Some varieties of sorghum yield a sweet sap which is extracted and made into a sirup, and these, the saccharine sorghums, or *sorgos*, were first introduced into the United States in 1853. At that time a Chinese sorgo, of the Black Amber type, was introduced from France. In 1857, Mr. Leonard Wray, an English planter who had collected a number of saccharine sorghums in South Africa, introduced his varieties into this country. Previous to 1880, several types of grain sorghums were also introduced. In 1876, two varieties of kafir were exhibited by the Orange River Colony at the Centennial Exposition in Philadelphia. About the same time varieties of durra were introduced from Northern Africa. A number of kaoliangs were also brought in from China and Manchuria. In the early part of the twentieth century *Feterita* and *Sudan grass* were introduced from Sudan. Some additional varieties of kaoliang were brought in from Northeastern Asia, as well as additional varieties of kafir from South Africa.

The sorghums at the present time have a very great value in American agriculture. The grain sorghums are well adapted to the southern Great Plains area, including western Kansas, western Oklahoma, northwestern Texas, eastern Colorado and eastern New Mexico. In this general region they have shown themselves a much more reliable crop than corn. It is an interesting fact that, with the exception of broom corn and the Black Amber types of sorgo, nearly all of our valuable sorghums have been introduced from Africa. The sorghums of India and the kaoliangs from Northern China and Manchuria have not proved to be particularly well adapted to our climatic conditions.

Distribution and Botanical Characteristics

All the sorghums are regarded as belonging to a single species of the grass family—*Holcus sorghum* L. (*Andropogon sorghum* [L.] Brot.). The wild forms of the species, which are closely related to Sudan grass, Tunis grass, etc., are widely distributed in Central and South Africa, Egypt, Madagascar and neighboring islands. These are annual plants without rootstocks and are differentiated into a number of distinct races or sub-species. Forms of these grass sorghums growing wild in Africa are nearly as large and coarse as some of the cultivated types, with which they readily hybridize.

The number of cultivated varieties of sorghums which are grown in the various parts of the world is extremely large. A relatively small number of these have been introduced into the United States, and as already noted most of the useful ones have been brought in from Africa. It is difficult when the varieties from all parts of the world are taken into account to adequately classify them, as the dividing lines between the different groups are very indefinite. They appear to hybridize with one another very readily so that new forms are constantly originating.

In general appearance the sorghums somewhat resemble corn or maize. The flowers, however, are perfect and the grain is borne in compact or loose panicles at the upper end of the stalk. The flowers appear to be generally self-pollinated, but cross pollination occurs so frequently that hybrids are constantly arising when two or more varieties are grown adjacent to each other. The sorghums are grown as a tillage crop and planted and cultivated in the same general manner as corn.

Agronomic Groups of Sorghum in the United States

The sorghums grown in the United States may be grouped into four agronomic classes:

1. *Broom corn.* This is grown primarily for the "brush" used in the manufacture of brooms.

2. *Grass sorghum.* The most important one is Sudan grass which is grown for forage for stock.

3. *Sorgo.* This group includes the sweet or saccharine sorghums used for the manufacture of sirup; many varieties, however, have proved to be extremely valuable as forage plants for stock, and in recent years large areas have been devoted to their cultivation for this purpose.

4. *Grain sorghum.* This group includes many varieties which are grown primarily for their grain, although the stems and leaves are also used as feed for stock.

BROOM CORN

Our modern broom corn has probably been derived from some sorghum with a loose open head and is grown primarily for the "brush," which consists of the panicle or branching inflorescence used in the manufacture of brooms. The stems and leaves have some value as stover or fodder for stock. The panicle varies from 15 to 24 inches in length and is umbelliform, with greatly elongated branches and drooping tips. The rachis or main axis is usually less than one-fifth the length of the panicle. The grains are reddish in color and included within the glumes.

There are at least three distinct varieties of broom corn grown in the United States. These differ mainly in the height of the plant, in the tenacity of the attachment of the peduncle to the upper node of the stem and in the length and texture of the brush. Standard broom corn has been grown for many years. In western Oklahoma it grows to a height of 8 to 10 feet, but under more favorable moisture conditions it reaches a height of 12 to 15 feet. The other varieties of broom corn are much shorter, ranging from 3.5 to 6 feet in height. At the present time dwarf broom corn composes about two-thirds of the total crop in this country, as it is especially well adapted to the climatic conditions of Oklahoma and adjacent regions.

Broom corn is grown in the same general fashion as corn and requires similar methods of tillage. The brush is harvested just after the flowering period and as late as the milk stage of development of the kernel. During this period the natural green color is developed throughout the branches of the panicle and, if properly cured, the brush is flexible and of the best quality. Immediately after harvesting, the broom corn is threshed by means of a special machine which removes the kernels. It is then usually placed in a specially-built drying shed where it is allowed to cure. After curing it is crated and baled for the market. The weather conditions during the harvesting period and the care taken in harvesting, threshing, curing, crating and baling are very important factors in determining the value of the final product.

The total acreage devoted to broom corn varies greatly from year to year. In 1923 approximately 500,000,000 acres were grown, over half of the acreage being in Oklahoma. The average yield in 1923 was about 278 pounds of brush per acre, and this had an average farm price of about $160 per ton, or about $22 per acre.

GRASS SORGHUM

There are several varieties of sorghums which have considerable value as grass or hay crops. The most important one is Sudan grass, which was first introduced into the United States in 1909, the grain being received from Director R. Hewison, Department of Agriculture and Lands, Sudan Government, Khartum, Sudan. Some later introductions have also been made, but practically all of the Sudan grass grown in the United States has come from the first importation. In 1918 the value of this crop was estimated at $10,500,000. Sudan grass is an annual, which grows rapidly and produces stems 4 to 6 feet high. It has proved to be a very desirable forage plant in the southern part of the United States and can be successfully grown as far north as Michigan and New York.

SORGO

The first variety of sorgo, or sweet sorghum, was introduced into the United States from China by way of France. In 1851, some grain was sent to France from the Island of Tsung Ming, but only one grain grew. The resulting plant had a tall slender stem and bore a loose panicle with more or less drooping branches and light brown seeds enveloped by black shiny glumes. Some grain was introduced into the United States in 1853 and, since many of our present forms of Black Amber sorgo show these same characters, it is probable that most of them have originated from this Chinese variety.

However, the majority of our sorgos have come from South Africa. Mr. Leonard Wray, an English sugar planter at Natal, South Africa, procured sixteen varieties which were grown by the various native tribes and called by them "Imphee." Wray brought these varieties to Europe about 1854 and arranged to have them grown in various countries. Fifteen of them were introduced into the United States and in 1857 were grown in Georgia and South Carolina. The original introductions were soon widely distributed over the United States. They hybridized readily and selections were made which resulted in a multiplication of so-called varieties. A large number of names has been recorded for the different sorgos, but the number of really distinct varieties is not very large.

Our American sorgos may conveniently be classified in five groups:

1. *Black Amber sorgo.* This group includes the various varieties or strains developed from the original Chinese importation. For the most part they are early maturing and are characterized by rather slender stems, narrow leaves, and panicles black in general color, due to the black shiny glumes which almost conceal the reddish yellow grains.

2. *Orange sorgo.* This group can be traced to one of the original Wray introductions from South Africa. The varieties have larger and thicker stems and more abundant leaves than the Black Amber group. The panicles are much heavier and more compact. The glumes are deep red or black at maturity, the reddish yellow seeds projecting between them and giving a lighter general color to the head as compared with the Amber varieties.

3. *Sumac sorgo.* This variety is also descended from one of Wray's original varieties. It has, however, remained quite true to type. It is a stout, stocky variety, 7 to 10 feet high, with an abundance of large leaves. The panicles are short, thick, cylindric, erect, 6 to 9 inches long, and sometimes spreading more or less at the tip.

The pedicels are very short and the seed is quite small; the glumes are shorter than the seed and vary from deep red to black in color.

4. *Gooseneck sorgo.* This variety is also probably derived from one of the original African varieties. It is very large, growing 10 to 15 feet high, with stems 1.5 to 2 inches in diameter at the base. The heads at maturity are 5 to 9 inches in length and 3 to 5 inches in width and almost black in color; they are recurved or pendent. Since the variety requires a long growing season it cannot be successfully grown very far north.

5. *Red Amber sorgo.* This variety is a recent importation from Australia and promises to be of great value in California as well as in the Great Plains area. It is characterized by red glumes and is more leafy and has a sweeter juice than the older Black Amber types.

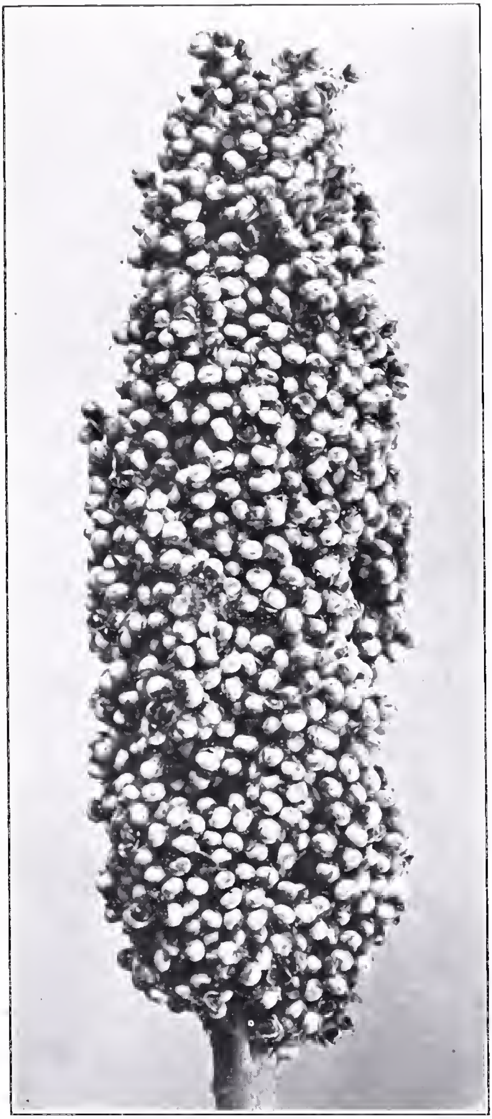
The cultivation of sorgos for the production of sorghum sirup is widely distributed throughout the United States, although the total quantity produced is not very great. In 1923 about 32 million gallons of sorghum sirup were produced. The average yield was about 84 gallons per acre, and the total farm value of the sorghum sirup was over $27,000,000. The five leading states in the commercial production were Kentucky, Mississippi, North Carolina, Georgia and Tennessee. Most all the crop is grown in comparatively small areas on the farms. In many places the sirup is extracted by comparatively crude methods. To some extent the farmers in the community will co-operate and have their sirup manufactured by a central factory which has installed modern machinery and up-to-date methods. The crop is harvested shortly before the seed is ripe, for at this stage there is the maximum amount of sugar. The essential points in the preparation of the sirup are the extraction of the juice from the stems by pressure, and later boiling down and clarifying.

In the southern Great Plains area the sorgos are grown quite extensively as forage for stock, as the juicy stems have proved to be an excellent feed for the farm animals. The crop is handled in practically the same manner as corn. A large proportion of it is made into silage.

GRAIN SORGHUM

This group of sorghums is grown primarily for the grain, which is extensively used as feed for stock. To some extent the grain is also used for making flour for pancakes and in the preparation of breakfast foods. The kinds grown in the United States may be placed in the following groups: durra, feterita, kafir, milo, kaoliang and shallu.

Durra.—There are two common varieties of durra in the United States: White durra in which the seeds are white and the lemmas are awned, and Brown durra with brown seeds and unawned lemmas. These forms are somewhat closely related to feterita and milo. They are characterized by slender to medium stout, dry, pithy stems. The panicles are short, broadly ovate, compact and recurved, although strains with erect heads have been developed. The glumes are greenish white, densely pubescent, and the seeds are very



Text Fig. 1. A head of Feterita. A valuable grain sorghum introduced from the Sudan, Africa.

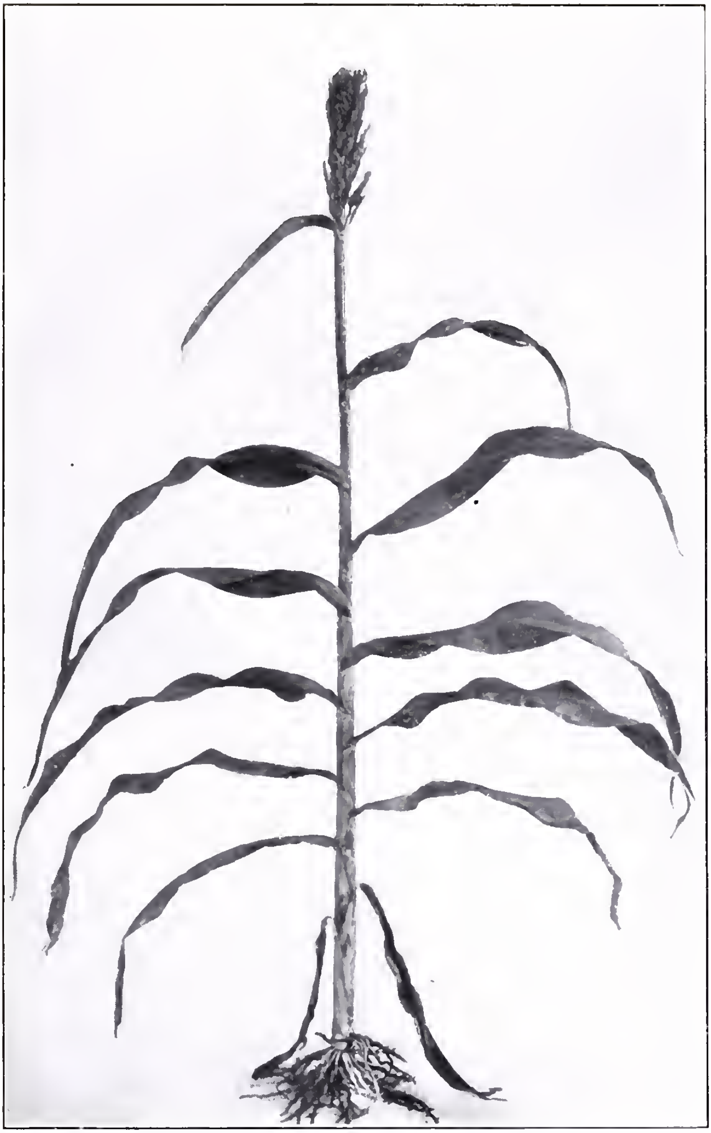
much flattened. The exact origin of our durras is not known, but a variety of sorghum very similar to our White durra is grown extensively by the Kabyles in Algeria. The White durra is also sometimes spoken of as White Egyptian corn and also as Jerusalem corn.

Milo.—The exact origin of our milos is unknown. Soon after 1880 a variety known as "Millo Maize" was grown in South Carolina and Georgia. It was later introduced into western Texas and the drier sections of adjacent states where it has proved to be a very successful crop, as it is able to produce grain and forage under conditions where corn and other crops fail. The stems of milo are medium in size and pithy. They grow to a height of 5 to 8 feet and bear 8 to 10 rather short narrow leaves. The heads are large, ovoid to oval, compact, and pendent or recurved, although sometimes more or less erect. The glumes are dark brown to black, mostly glabrate and transversely wrinkled. The seeds are large, salmon or white in color, somewhat flattened, and about one-third enclosed in the glumes. From the original type four distinct varieties differing in height and color of the seed have been selected. The best general variety is the Dwarf Yellow milo which grows to a height of about 4 to 5 feet.

Feterita.—This sorghum is proving one of our best grain types. It was first obtained in 1901 from Alexandria, Egypt; but it came originally from Sudan, where it is known as Sudan durra. Feterita is quite similar to milo in most of the characters of the stalks and leaves. It averages about 5 feet high, has dark brown to black, pubescent to glabrate, transversely wrinkled glumes, unawned lemmas, and erect and nearly oval panicles. The seeds are chalky or bluish white and less flattened than in the durras. (See Text Fig. 1.)

Kaoliang.—The kaoliangs have been introduced from the northern parts of China and Manchuria, and constitute quite a distinct group of grain sorghums. The introduced varieties vary greatly in height, earliness, productiveness and other qualities. Only one variety, the Manchu, has become agriculturally important in the United States, being grown to some extent in South Dakota where its cultivation seems to be increasing. Kaoliangs have a slender, dry, pithy stem; the internodes are usually long and the plant bears 7 to 10 leaves; the panicle is compact. The introduced varieties may be grouped as follows: 1. White kaoliangs, possessing white glumes and white grains; 2. Blackhull kaoliangs distinguished by black glumes and white grains; 3. Brown kaoliangs characterized by brown or reddish brown glumes and grains; 4. The Blackhull Brown kaoliangs, with black glumes and seed of some shade of brown or reddish brown.

Shallu.—About 1890 a variety of shallu was introduced from India by the Louisiana Agricultural Experiment Station under the name of Egyptian wheat. It has been extensively advertised in various parts of the country. It, however, does not possess much value as compared with the other grain sorghums. It has slender, dry stems which grow 5 to 8 feet tall in the southern Great Plains



Text Fig. 2. A plant of Dawn Kafir at blooming time. This variety grows from 3.5-4 feet high in the Great Plains area. It is valuable for both grain and forage.

area. The heads are large, stiff, conical, and pale yellow in color. The long slender branches of the heads spread and droop at the tips. The young grain is closely enveloped by the greenish yellow glumes, but as it ripens they turn to a dull brown color, open widely, and expose the grain. The ripe grains are ovoid, somewhat flattened, and whitish to pale buff in color.

Kafir.—Six distinct varieties of kafir are more or less extensively grown in the United States. Two of these, White kafir and Red kafir, were introduced from southeastern Africa in 1876 when they were exhibited by the Orange Free State at the Philadelphia Exposition. The kafirs vary considerably in size and earliness, and are distinguished by their stout, stocky, semi-juicy stems with short internodes and overlapping leaf sheaths. The leaves are broad, 11 to 16 in number. The panicles are erect and slender. The glumes are shorter than the grain and the lemmas not awned.

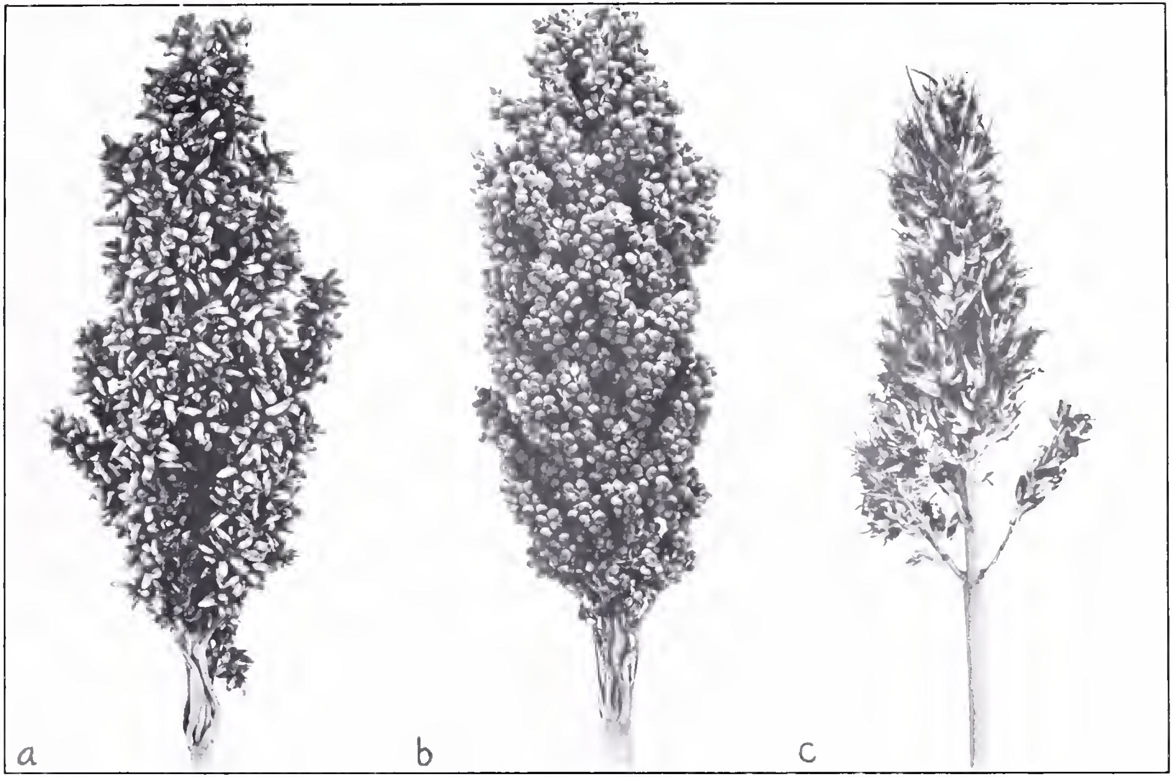
One of the best varieties is Blackhull kafir, distinguished by black glumes and white grains. Recently Sunrise kafir and Dawn kafir have been developed, the original head from which they were selected being collected in the autumn of 1906 in a field of Blackhull kafir. The grain from this head was planted the next season and two selections were made which became the progenitors of Sunrise and Dawn kafir. They both resemble Blackhull kafir in maturing earlier and are dwarfer. Dawn kafir is shorter and somewhat earlier than Sunrise. (See Text Fig. 2.) It is possible that both Sunrise and Dawn have been selected from the progeny of a chance hybrid between Blackhull kafir and White kafir, the latter imparting earliness, dwarf stature and shorter peduncles to the progeny. The kafirs are valuable both as grain and forage plants. Much of the crop grown is used for silage.

The general methods of handling the grain sorghums are the same as for corn. They are planted and cultivated by similar machinery. At harvest time the fields are usually cut by a corn harvester and stood in shocks for curing. Later the grain is threshed out by a special machine and the stems and leaves used for forage. In other cases the grower drives through the field with his team and cuts the ripe heads from the standing grain. The stock are later turned into the field and utilize the rest of the plant.

The grain sorghums have proved to be a great boon to the farmers of the southern Great Plains area. They are well adapted to the conditions which prevail in that region where the annual precipitation is low and unevenly distributed throughout the year. In 1923 5,776,000 acres were devoted to them, the leading states in production being Texas, Kansas and Oklahoma. The average yield of grain was 18.3 bushels per acre and the average price per bushel was $.94, the total farm value being approximately $100,000,000.

SORGHUM SMUTS

The sorghums have their quota of fungous diseases. The most serious ones appear to be the smuts. The covered kernel smut (*Sphacelotheca sorghi* [Link] Clinton) is apparently co-extensive with the cultivation of sorghums, frequently causing very heavy losses.



Text Fig. 3. A. Covered kernel smut of sorghum on Sumac sorgo.
B. Normal head of Sumac sorgo.
C. Loose kernel smut of sorghum on Valley Kaoliang.

In the United States it is not uncommon to find fields which show 20 to 50 per cent of the heads destroyed by this disease. The infection of the sorghum plant takes place in the seedling stage from spores adhering to the grain. The infected plants, however, cannot be detected until about the time of heading out; then the enlargement of the ovaries due to the unusual development of the parasite is easily observed. These hypertrophied kernels constitute the smut balls, which contain enormous numbers of dust-like spores. The smut balls are broken in threshing and similar operations and the spores come in contact with the sound grain.

The life history of the parasite causing loose kernel smut (*Sphacelotheca cruenta* [Kühn] Potter) is somewhat similar to that of the covered smut, but its pathological effects are strikingly different. The infected plants head out earlier than the normal and are noticeably dwarfed in nearly all sorghum varieties; they also show more tillering and branching as compared with the normal. The smut balls are much longer, more slender and cylindric in shape. They break open very readily and permit the distribution of the spores, the rupturing of the membrane occurring even before the smut ball has completely emerged from the glumes. While the loose smut fungus obtains entrance into the host through the young seedling, it has recently been demonstrated that infection can take place in the field either through young panicles or individual flowers from the spores on the early-heading infected plants.

The head smut (*Sorosporium reilianum* [Kühn] McAlpine) differs from the two kernel smuts in the fact that usually the entire head is more or less completely converted into a mass of smut spores. It is not so common as the covered kernel smut, but in certain localities it is destructive to some varieties of sorghum. It seems to depend for its distribution very largely upon spores in the soil. This smut is also particularly interesting from the fact that it occurs on maize as well as on sorghum.

Extensive studies have been made on the resistance of sorghum varieties to the common smuts, particularly the covered and loose kernel smuts. The varieties of broom corn, durra, kafir and sorgo seem to be quite susceptible. On the other hand, Feterita and the milos have shown a high degree of resistance to both the kernel smuts.

Great improvement has been made in the development of American sorghums. The introduced types were usually very variable, but by careful selection varieties have been secured which are uniform in height, time of maturing, as well as increased yield. Although the sorghums are usually self-pollinated and consequently breed true, yet a considerable amount of cross-pollination may take place between different varieties grown adjacent to each other. Extensive hybridization is possible within the group, which may be the basis for developing new varieties.

Breeding for smut resistant types combining various agronomic features offers a fertile field for investigation. The study of the inheritance of smut resistance in crosses involving susceptible and resistant varieties is also a particularly interesting one.

GEORGE M. REED.

CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XIII BROOKLYN, N. Y., MAY 13, 1925 No. 4

TWELFTH ANNUAL GARDEN EXHIBIT FOR BROOKLYN BOYS AND GIRLS

Twelve years ago the Brooklyn Botanic Garden held its first fall garden exhibit for the boys and girls of the Borough. The displays in this exhibit represented the work in school gardens and home gardens. The response was so enthusiastic and fine that the Botanic Garden has repeated the exhibit now for these twelve years. This fall's exhibit is to close the series.

The original thought behind the plan for an annual garden exhibit was this: to establish among the boys and girls in the Borough a more enthusiastic interest in gardening and to help schools in every way possible in work with gardens. The work of school gardening and home gardening in the Borough of Brooklyn is now well established. The City of New York has its own Director of School Gardens, Mr. Van Evrie Kilpatrick, and the work is now on a firm basis. The real need for the Botanic Garden Exhibit is perhaps over. We hope that this final exhibit will be a lovelier one than ever in order that the close may be one of splendid climax to twelve years' work.

The exhibit will differ this year in several ways from exhibits of years gone by. The school exhibits will fall into one class of School Displays. These displays should represent garden work and its allied activities. Each school exhibit may be made up wholly of products from school gardens; it may have connected with it compositions on garden work; maps, plans, projects, paintings or drawings done by the children, and notebooks. In fact, each exhibit is supposed to be in itself a comprehensive unit of garden work. These exhibits will be set up and marked with their school numbers.

For three years we have had Classes A, B and C for schools; A, School Display of Vegetables; B, School Display of Potted Plants; C, an Open Class. In Classes A and B, two schools, P. S. 109 and P. S. 129, have carried off the first prize for two years. To win this prize for permanent holding a school must have won it three times. This year, since there are no definite school classes A and B, these schools will receive these first prizes if the exhibits they set up are of first class character; but these schools, regardless of the quality of their exhibits, may not compete for the other prizes.

ENTRY CLASSES

I. School Display—Open to all schools in the Borough of Brooklyn. Flowers, vegetables, window boxes, garden plans, compositions, pictures, garden-nature project work, may all be entered to make a harmonious whole. The use of crepe paper as a background medium is prohibited.

II. Individual Displays—Open to boys and girls of the Borough of Brooklyn. The entries must have been cared for by the exhibitor.

Class A—**Flowers.** The number of sprays may vary from seven to eleven: arrangement to be made by exhibitor.

No. 1. Aster, pink
No. 2. Aster, white
No. 3. Aster, blue
No. 4. Aster, mixed
No. 5. Dianthus (Garden Pink)
No. 6. Marigold, tall
No. 7. Marigold, dwarf
No. 8. Nasturtium
No. 9. Sunflower
No. 10. Zinnia

Class B—**Vegetables.** Number of specimens for each entry in this class listed as follows:

No. 1. Beans, bush
  Best pint, shelled
No. 2. Beans
  Best quart, unshelled
No. 3. Beets
  Best bunch of 6
No. 4. Carrots
  Best bunch of 5
No. 5. Kohlrabi
  Best 4
No. 6. Peppers, green
  Best 4
No. 7. Peppers, red
  Best 4
No. 8. Pumpkin
  Best specimen
No. 9. Squash
  Best specimen
No. 10. Tomatoes, green
  Best 8
No. 11. Tomatoes, red
  Best 8
No. 12. Tomatoes, small-fruited
  Best 10

Class C—**Best Special Plant.** Any plant cared for by the exhibitor may be entered.

Class D—**Best Bunch of Flowers.** Judged on taste and arrangement.

DETAILS FOR ENTRY TO FINAL EXHIBIT AT THE BROOKLYN BOTANIC GARDEN

Time—The Twelfth Annual Garden Exhibit of the Brooklyn Botanic Garden will be held Saturday and Sunday, September 26 and 27. The exhibit will be open on Friday afternoon, September 25, at two o'clock, for school children with their teachers, but not for the general public.

Place—The exhibit will be held in the central rotunda of the Laboratory Building, at the Brooklyn Botanic Garden. The building may be entered either from Washington Avenue, No. 1000, or from the Garden side.

Conditions of Entry—Schools must bring their own exhibits and place them. They must be placed by one o'clock at the latest, on Friday, September 25. Entry cards may be obtained September 9, or until the day of the Exhibit. Exhibits may be brought in September 24 from 2 p. m. to 4 p. m., but preferably from 8 to 12:30 on September 25.

Judging—The point system of judging will be used. The exhibits will be judged on the following points: arrangement, quality of material, placing of exhibits, number of school activities represented. The judging will take place at 1 p. m. September 25. Our judges this year will be Mr. Van Evrie Kilpatrick, Director of Nature-Garden Work for New York City; Mr. Arthur Dore, Managing Editor of the Brooklyn Citizen, and Mrs. William H. Good, member of the Board of Trustees of the Botanic Garden.

Prizes—The first prize will be a cup. The second prize will be four books from The Nature Library of Doubleday, Page & Company; third prize, three books from The Nature Library; honorable mention, two books. All schools entering will receive an entry prize of one nature book from this Library. Schools may make their own selection of the books desired from The Nature Library.

Removal of Exhibits—Exhibits may be removed during the week of September 28.

Presentation of Prizes—Prizes will be presented on October 24 at 2:30 p. m., in the auditorium of the Brooklyn Botanic Garden building.

To All Schools—We trust you will take advantage of this last exhibit to be given at the Brooklyn Botanic Garden and help make it the most wonderful display of all our twelve exhibits.

Ellen Eddy Shaw,
Curator of Elementary Instruction.

The Leaflets are published weekly or biweekly from April to June, and September to October, inclusive, by the Brooklyn Botanic Garden, Brooklyn, N. Y.

Telephone: 6173 Prospect. Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

THE BROOKLYN BOTANIC GARDEN

ANNOUNCES

A COURSE IN SPRING NATURE STUDY

By

MABEL E. TURNER

Instructor, Brooklyn Botanic Garden

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This is a short course consisting of three lessons on successive Mondays at 4 p. m., beginning May 11, and is planned especially for the assistance of teachers who wish to give their pupils an acquaintance with nature in the spring months. Any others interested are welcome. The following subjects will be considered: trees and shrubs; butterflies and moths; wildflowers; birds.

At each lesson of the series, where possible, material suitable for classroom work in Nature Study will be distributed to the class.

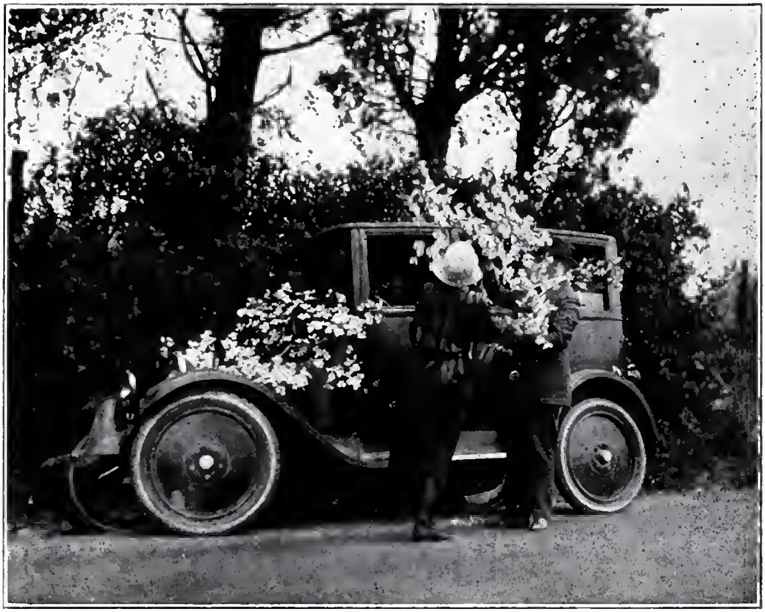
The course is free to those enrolled as members of the Brooklyn Botanic Garden: for others a fee of $2 is charged. Those desiring to register should send their names at once to the Secretary, Brooklyn Botanic Garden, 1000 Washington Ave.

To Reach the Garden take Broadway (B-M.T.) Subway to Prospect Park Station; Interborough Subway to Eastern Parkway-Brooklyn Museum Station; Flatbush Avenue trolley to Empire Boulevard; Franklin Avenue, Lorimer Street, and Tompkins Avenue trolleys to Washington Avenue; St. John's Place trolley to Sterling Place and Washington Avenue; Union Street and Vanderbilt Avenue trolleys to Prospect Park Plaza and Union Street.

Entrances.—On Flatbush Avenue (1) near Empire Boulevard (Malbone Street), and (2) near Mt. Prospect Reservoir; on Washington Avenue, (3) south of Eastern Parkway, and (4) near Empire Boulevard; on Eastern Parkway, (5) west of the Museum Building.

The street entrance to the Laboratory Building is at 1000 Washington Avenue, between Eastern Parkway and Empire Boulevard and opposite Montgomery Street.

THE CONSERVATION OF BEAUTY



When you are about to do this, STOP and THINK!

1. Would you take these flowers if they adorned the roadway in front of your house?
2. If you take some, and everyone else takes some, how many will be left for other people to enjoy?
3. Do they belong to you anyway?

Brooklyn Botanic Garden Leaflets

SERIES XIII   BROOKLYN, N. Y., JUNE 10, 1925   Nos. 5 and 6

The funds for this issue were contributed by the Torrey Botanical Club, the New York Bird and Tree Club, the American Fern Society, the New York Association of Biology Teachers, and the Brooklyn Botanic Garden. The photographs are by Messrs. P. L. Ricker (Laurel) and L. W. Brownell (Gentian).

"From its late-flowering, its rare color (though unless seen under a very clear sky it is more purple than blue), coupled with Bryant's poem, a sentiment has grown about the Gentian that fills the casual tourist and flower-lover alike with the greed for its possession. Taken indoors, it closes, takes on a sullen hue, and quickly withers, and yet the impulse to possess is driving it from our state." (From "Wild Flowers and Ferns: When and How to Gather Them," written for the Fairfield (Conn.) Garden Club by Mabel Osgood Wright.)

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XIII BROOKLYN, N. Y., JUNE 10, 1925 NOS. 5 AND 6

THE CONSERVATION OF BEAUTY*

The conservation of useful things in nature has come to be accepted as public policy. For twenty-five and more years sentiment for forest conservation has been gradually growing until today we find the New York State Legislature considering a bill which proposes that the state shall assume control of timber land, public and private—which says that the lumberman must obtain permission from the state authorities before he may harvest the tree crop on his domain.

Do you know how important this forest problem really is? Do you realize that the unification and commercial development of this country were made possible by the abundant supply of timber for railroad ties, that commerce on the sea still makes large demands on forests for ships and ship outfittings? In the early history of Connecticut, the tall pines were so well formed that they were specially set aside by royal edict to be cut only for the king's navy. Now we are again considering whether as a sovereign people we may not control the forest resources of the state.

Every one knows that forests are our chief sources of building material; that a vast number of homes throughout the country depend upon wood for fuel, but how many have realized that modern education and the diffusion of news and entertainment are based on the cheap paper which is a forest product? How many know that forests are the original reservoirs in which is stored water for drinking, for power, and for navigation? That when forests are ruthlessly cut off, rivers rush every spring in disastrous floods, and then run low in the summer? Forests hold soil from being washed away. They furnish foods, materials for basic industries, such as turpentine, acetic acid, et al. They serve as homes for birds, man's best friend in the warfare against destructive insects. Here in New York, thousands of city dwellers also find forests delightful places for recreation throughout the summer.

But my theme is not of useful things which need conservation. I want to present another phase of the conservation problem, the conservation of the beauties of nature as found in the ferns and flowering plants which inhabit the fields and forests. We must save the useful things of the forests if we are to maintain standards

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*This *Leaflet* is a reprint, revised and enlarged, of Series XII, No. 2, 1924.

of living as they are at present. But for the wild flowers which are diminishing in numbers, we can make no claim of economic value. Their beauty is their only appeal.

Their beauty is also their danger. Their friends are their enemies. The armies of hikers and automobile parties, which fare forth from every large city throughout the spring and summer, answer natural instincts when they gather wild flowers by the armful. But some wilt in a few minutes, and some become burdensome and are thrown away as the day wears on or better flowers are found. Whatever the reason, it is certain that the beauties of the woods and fields are disappearing, especially in regions within range of cities.

Some one may ask whether the natural means of increase do not take care of the demand; if these plants are not prolific enough so that the supply will be maintained year after year? The answer is found in the simple fact that they *are* disappearing; that wild flowers once common have become rare, and that rare kinds have become practically extinct within a large radius of our big cities. The answer is further found in a consideration of some of the facts of the structure and reproduction of these native plants.

Some of the choicest kinds depend entirely on seed for their reappearance year by year. If you pick the fringed gentian in September and leave no flowers for setting seed, that field will cease to know it. Even many perennial plants which may live through several years eventually depend upon flowers and seed production for existence and distribution.

Other kinds, normally perennial by underground stem and roots, are destroyed by picking because practically the whole plant above ground is taken. With the trillium, which beautifies May woods with its several species, the picker always takes the three foliage leaves with the flowers, and the plant perishes as surely as an animal whose breathing and digestion have been stopped.

Some species are killed or seriously injured by careless picking. The mayflower or arbutus creeps along the ground with a tenuous hold by its scattered roots. The picker in a hurry pulls off the flowering portion and loosens or uproots the rest of the plant which should remain for next year.

Some native plants are so rare that one may see but a single specimen in a long day's visit to the woods. Most wild orchids are in this category. New York State has one fern species for which there are localities in only two counties, and which is known elsewhere in the United States in only one other state. When such rarities attract the careless picker their knell is sounded.

Some flowering shrubs and trees produce such a profusion of color that a single plant may dominate a landscape. Surely a vigorous dogwood or laurel can spare a spray of its beauty to the early visitor. If, however, it is on a travelled road or trail, the first visitor will not be the last, and before the day is over, the plant which began the day with a magnificent display of beauty, may have become a thing of broken and splintered stumps, robbed of its flowers, and permanently crippled if not killed by thoughtless flower lovers.

What is the remedy? Has the wild flower any rights? Can it not call upon the state for legal protection? Some twenty-five years ago the boy nature-lover was encouraged to follow his bent by collecting the nests and eggs of native birds. But our bird life came to be known as economically important as our allies against crop-destroying insects, as well as beautiful bits of life. Now the protection of birds is written into our state conservation laws with unmistakable force and effect.

But wild flowering plants cannot be given legal protection on the same stringent basis as birds. For trees the protection of the state may properly be invoked because with the loss of tree cover the whole state will suffer. Otherwise a plant is the absolute property of the owner of the land in which it is rooted, and he may do as he wishes with it; he may plow it up; he may sell it, and purchasers may further dispose of it as they wish.

However, it has been found possible to afford some measure of legal protection to native wild plants. Before 1925, six states had already passed "Game Laws" for their protection: Connecticut, California, Maryland, Vermont, Illinois and Wisconsin. During the recent legislative session New York State joined this list with a law introduced by Assemblyman T. Channing Moore, which gives special protection to the trailing arbutus when it is growing on state land. Massachusetts and Pennsylvania also report plant protection laws this year.

It is an important step to have legal recognition of native plants as entitled to the special consideration of this state. The New York State law is a good beginning. In general we should consider now what further plans of action will best aid in this problem of conservation of beauty in nature.

Here follow a number of definite proposals:

1. Further legal action not only to aid particular species which are threatened with extinction, but also along even broader lines. For example, the protection of wild flowers on private property would be aided if the wanton destruction could be made punishable by stronger provisions in the trespass laws. Again, we ask the inclusion of native plants in the "Private Parks" section of the conservation law, to the end that land owners may post their property as *plant sanctuaries* along the lines that are now authorized for the protection of native animals. Laws covering these two aims were also introduced at the recent legislative session at Albany but failed of passage. We may hope eventually that the State will be interested to begin experimental propagation of some of the rarer species with the idea of distributing seeds and young plants in the same way that it now distributes small fish.

2. Plant sanctuaries may be established by private individuals or communities without waiting for special state sanction. The present trespass laws give a basis for protection. Definite recognition

(in the State law) of plants as worthy of protection is important, but until such a law is obtained, the way to conserve wild plants is to conserve them. Such a beginning has been made in Fairfield, Conn., in an endowed sanctuary instituted originally for birds, but with wild plant protection as an important part of its aim. This little sanctuary also gives valuable aid to the local educational work. No one would wish to stop the return to nature which finds expression in the hiking clubs, scouting, etc., of today. We can never hope to make our parks and state play grounds completely safe for rare wild flowers. Every child passes through a stage in his development when the urge to pick would transcend any recently acquired inhibition. But if, through private initiative, tracts of land are set aside and protected, where picking is prevented and propagation is practised, we may hope to conserve many species which will otherwise entirely disappear.

3. Constructive education, throughout the year, but with special emphasis during the spring, is important. Get a conservation program presented before some meeting of any organization which can be interested. Lectures with lantern slides can probably be arranged for throughout the state. In New York City, the American Museum of Natural History, the Brooklyn Botanic Garden, and the New York Botanical Garden may be applied to for lectures for school programs, and the American Museum and the Brooklyn Botanic Garden will also loan sets of slides with lecture outlines.

A particularly valuable article entitled "Wild flowers and how to pick them," by Mabel Osgood Wright, has been issued by the Fairfield (Conn.) Garden Club. In this is stressed the positive side; that many flowers may be picked without stint, like the daisy, Queen Anne's lace, and others, some of which have all the grace of the rarest species, but are almost weeds to the farmer.

4. A specially valuable line of constructive work is that concerned with the artificial propagation and increase of some of the disappearing species. A recent number of the *Journal of the New York Botanical Garden* contained articles of this type. Mrs. N. L. Britton of the New York Garden has been for many years a leader in the whole movement for wild flower protection, and may be addressed for valuable literature on the subject.

5. Finally, the legislative and administrative officers of New York State should be informed of the widespread and serious interest in this subject. Secure the support of organizations in the form of resolutions and petitions for state action. The program already has the sympathetic interest and support of legislators, but they will be glad to receive evidence of general backing. Such communications may be addressed to Governor Alfred E. Smith, to the Chairman of the Conservation Commission of the Senate, to Assemblyman T. Channing Moore, and to Alexander Macdonald, Conservation Commissioner, all at Albany, N. Y.

RALPH C. BENEDICT.

The New York State Conservation Law, as amended to provide protection for trailing arbutus, reads as follows:

AN ACT to amend the penal law, in relation to taking, injuring and destroying trees, wild flowers and other vegetation growing on public and private lands.

Became a law April 1, 1925, with the approval of the Governor. Passed, three-fifths being present.

Section 1. The caption of section fourteen hundred and twenty-five of the penal law is hereby amended to read as follows: Wilful or malicious injury to and taking, injuring or destroying property, and desecration of the flag.

§ 2. Subdivisions two and three of such section fourteen hundred and twenty-five of such chapter are hereby amended to read as follows:

2. Cuts down, girdles or otherwise injures or destroys, a fruit, shade or ornamental tree standing on the lands of another, or takes, picks, plucks, severs, carries away, removes, injures or destroys any wild or cultivated trailing arbutus (epigaea repens) growing on the lands of the people of the state, or in any street, highway, public place or park belonging to or under the control of any county, city, town or village; or

3. Severs from the freehold of another, or of the people of the state, any produce thereof, or any thing attached thereto; or,

§ 3. Subdivision four of such section fourteen hundred and twenty-five of such chapter is hereby amended to read as follows:

4. Digs, takes, or carries away without lawful authority or consent from any lot of land in any city or incorporated village, or from any lands included within the limits of a street or avenue laid down on the map of such city or village, or otherwise recognized or established, any earth, soil, or stone, or,

§ 4. This act shall take effect immediately.

The Brooklyn Botanic Garden is active in the movement for the conservation of our native ferns and wild flowers. An annual membership in the Garden at $10 a year affords an opportunity for individuals to cooperate in this work. For full information address the Secretary, Brooklyn Botanic Garden.

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Some native plants are so rare that one may see but a single specimen in a long day's visit to the woods. Most wild orchids, like the twayblade in this illustration, belong in this category. When such rarities attract the careless picker, their knell is sounded.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XIII BROOKLYN, N. Y., OCTOBER 14, 1925 NOS. 7–9

A PRELIMINARY LIST OF NATIVE AND NATURALIZED WOODY PLANTS OF GREATER NEW YORK

As all New Yorkers know, the territory included in the term "Greater New York" is not all a region of skyscraper office buildings and huge apartment houses. The five boroughs—Manhattan, Brooklyn, Bronx, Queens and Richmond (Staten Island), cover more than 315 square miles—equal to nearly one-third the area of the State of Rhode Island, and more than five times as large as the District of Columbia.

And although Greater New York contains a population which is itself half again as great as that of the whole State of Massachusetts, there are still large sections with woods and fields, in addition to a park system totalling more than 8,000 acres, much of which has been kept in a state of nature. Probably the greatest amount of wild land is found on Staten Island (Borough of Richmond), particularly in the southern and western parts. Large wooded sections occur in Queens, especially along the ridge north of Jamaica and Hollis, marking the terminal glacial moraine, and also in the neighborhood of Flushing. Much of Forest Park is natural woodland. In the Bronx, much of Van Cortlandt Park and of Bronx Park have been preserved as far possible in their original condition. The country in and about Pelham Bay Park is also an attractive region for botanical exploration. Even in much-settled Manhattan, Inwood Park, at the extreme northern end of the borough, is a wild, wooded section; and a small part of Central Park, particularly at the north end, is natural woodland. All these areas are easily accessible to the New Yorker by subway, trolley or bus connections.

The trees and shrubs are the most conspicuous features of the vegetation of this part of the country. One who is acquainted with them knows a large part of the bulk of the vegetation and has made a good beginning toward an acquaintance with the flora as a whole. The following list of native and naturalized woody plants has been prepared as an aid to those who are interested in their identification; for in this work it is always of assistance to know what kinds to expect in a given locality.

The list is also designed for use in the classes at the Brooklyn Botanic Garden.

The names of the plants conform in most cases to those used in Gray's Manual of Botany, seventh edition. The species printed in bold-faced type are those native in this region which are of common occurrence. Of the naturalized species, both those from foreign countries and from other parts of the United States, the following are common: *Salix fragilis, Salix vitellina, Populus alba, Morus alba, Pyrus Malus, Prunus Avium, Robinia Pseudo-Acacia, Ailanthus glandulosa,* and *Lonicera japonica.* The political boundaries of the City of Greater New York have been closely adhered to: for example, several species found on the Palisades, across the Hudson from Manhattan, are not included. Foreign species which are naturalized or are adventive are in large and small capitals. Species native in the United States, but not in the New York area, which, however, have been naturalized here, are in large capitals. The list as a whole is a tentative one and makes no pretensions as to completeness. We hope that those interested will coöperate in making it more complete and accurate, by additions or corrections.

*—Shrub.
**—Woody climber.

All other species are classed as trees.

PINACEAE PINE FAMILY

PINUS

P. Strobus L.	**White Pine**
P. virginiana Mill.	Scrub Pine
P. echinata Mill.	Shortleaf Pine
P. rigida Mill.	**Pitch Pine**

TSUGA

T. canadensis (L.) Carr.	**Hemlock**

JUNIPERUS

J. virginiana L.	**Red Cedar**

SALICACEAE WILLOW FAMILY

SALIX

S. nigra Marsh.	**Black Willow**
S. lucida Muhl.	Shining Willow
S. FRAGILIS L.	CRACK WILLOW
S. ALBA L.	WHITE WILLOW
S. BABYLONICA L.	WEEPING WILLOW
S. VITELLINA L.	GOLDEN WILLOW
***S. cordata** Muhl.	**Heartleaf Willow**
***S. discolor** Muhl.	**Pussy Willow**
*S. humilis Marsh.	Prairie Willow
*S. tristis Ait.	Dwarf Gray Willow
S. rostrata Richards.	Beak Willow
*S. candida Flügge	Sage Willow
*S. PURPUREA L.	PURPLE WILLOW
***S. sericea** Marsh.	**Silky Willow**

POPULUS

P. ALBA L.	WHITE POPLAR
P. tremuloides Michx.	**Quaking Aspen**
P. grandidentata Michx.	**Largetooth Aspen**
P. CANDICANS Ait.	BALM OF GILEAD
P. deltoides Marsh.	**Cottonwood**

MYRICACEAE BAYBERRY FAMILY

MYRICA

***M. carolinensis** Mill.	**Bayberry**
M. Gale L.	Sweet Gale

COMPTONIA

***C. asplenifolia** Gaertn.	**Sweet Fern**

JUGLANDACEAE WALNUT FAMILY

JUGLANS

J. cinerea L.	**Butternut**
J. nigra L.	**Black Walnut**

CARYA

C. ovata (Mill.) K. Koch	**Shagbark Hickory**
C. alba (L.) K. Koch	**Mockernut**
C. glabra (Mill.) Spach	**Pignut**
C. cordiformis (Wang.) K. Koch	**Bitternut**
C. microcarpa Nutt.	Small Pignut

BETULACEAE — BIRCH FAMILY

CORYLUS

C. americana Walt.	**American Hazelnut**

OSTRYA

O. virginiana (Mill.) K. Koch.	**Hophornbeam**

CARPINUS

C. caroliniana Walt.	**Blue Beech**

BETULA

B. lenta L.	**Sweet Birch**
B. lutea Michx. f.	**Yellow Birch**
B. nigra L.	River Birch
B. populifolia Marsh.	**Gray Birch**

ALNUS

*A. incana (L.) Moench	Speckled Alder
***A. rugosa** (DuRoi) Spreng.	**Smooth Alder**
A. GLUTINOSA Gaertn.	EUROPEAN ALDER

FAGACEAE — BEECH FAMILY

FAGUS

F. grandifolia Ehrh.	**American Beech**

CASTANEA

C. dentata (Marsh.) Borkh.	**American Chestnut**

QUERCUS

Q. alba L.	**White Oak**
Q. stellata Wang.	**Post Oak**
Q. bicolor Willd.	**Swamp White Oak**
Q. prinoides Willd.	Dwarf Chinquapin Oak
Q. Prinus L.	**Chestnut Oak**
Q. rubra L.	**Red Oak**
Q. palustris Muench.	**Pin Oak**
Q. coccinea Muench.	**Scarlet Oak**
Q. velutina Lam.	**Black Oak**
Q. ilicifolia Wang.	**Scrub Oak**
Q. marilandica Muench.	Blackjack Oak
Q. Phellos L.	Willow Oak
Q. Rudkini Britton	Rudkin Oak
Q. Brittoni W. T. Davis	Britton Oak
Q. heterophylla Michx. f.	Bartram Oak

URTICACEAE — NETTLE FAMILY

ULMUS

U. fulva Michx.	**Slippery Elm**
U. americana L.	**American Elm**

CELTIS

C. occidentalis L.	**Hackberry**

MACLURA

M. POMIFERA (Raf.) Schneider	OSAGE ORANGE

BROUSSONETIA

B. papyrifera (L.) Vent.	Paper Mulberry

MORUS

M. rubra L.	Red Mulberry
M. alba L.	White Mulberry

MAGNOLIACEAE — MAGNOLIA FAMILY

MAGNOLIA

M. virginiana L.	Sweet Bay

LIRIODENDRON

L. Tulipifera L.	**Tulip Tree**

MENISPERMACEAE — MOONSEED FAMILY

MENISPERMUM

**M. canadense L.	Moonseed

BERBERIDACEAE — BARBERRY FAMILY

BERBERIS

*B. vulgaris L.	European Barberry

LAURACEAE — LAUREL FAMILY

SASSAFRAS

S. variifolium (Salisb.) Ktze.	**Sassafras**

BENZOIN

***B. aestivale** (L.) Nees	**Spice Bush**

SAXIFRAGACEAE SAXIFRAGE FAMILY

RIBES

*R. floridum L'Her.	Wild Black Currant

PHILADELPHUS

*P. coronarius L.	Mock Orange

HAMAMELIDACEAE WITCH-HAZEL FAMILY

HAMAMELIS

H. virginiana L.	**Witch Hazel**

LIQUIDAMBAR

L. Styraciflua L.	**Sweet Gum**

PLATANACEAE PLANE-TREE FAMILY

PLATANUS

P. occidentalis L.	**Sycamore**

ROSACEAE ROSE FAMILY

PHYSOCARPUS

*P. OPULIFOLIUS (L.) Maxim.	NINE-BARK

SPIRAEA

***S. latifolia** Borkh.	**Meadow-sweet**
***S. tomentosa** L.	**Hardhack**

PYRUS

P. communis L.	Pear
P. Malus L.	Apple

ARONIA

***A. arbutifolia** (L.) Medic.	**Red Chokeberry**
***A. atropurpurea** Britton	**Purple-fruited Chokeberry**
*A. melanocarpa (Michx.) Britton	Black Chokeberry

AMELANCHIER

A. canadensis (L.) Medic.	**Shad Bush**
A. oblongifolia (T. & G.) Roem.	Southern Swamp Shad Bush

CRATAEGUS

C. Oxyacantha L.	English Hawthorn
C. coccinea L.	Scarlet Thorn
C. Crus-galli L.	Cock-spur Thorn
C. tomentosa L.	Dwarf Thorn

RUBUS

*R. phoenicolasius Maxim.	Wineberry
***R. occidentalis** L.	**Black Raspberry**
*R. odoratus L.	Purple Flowering Raspberry
*R. triflorus Richards.	Dwarf Raspberry
*R. allegheniensis Porter	Mountain Blackberry
***R. frondosus** Bigel.	**Leafy Blackberry**
*R. cuneifolius Pursh.	Sand Blackberry
***R. hispidus** L.	**Swamp Blackberry**
***R. villosus** Ait.	**Dewberry**

ROSA

*R. carolina L.	Swamp Rose
*R. rubiginosa L.	Sweetbrier
*R. virginiana Mill.	Virginia Rose
*R. humilis Marsh.	Pasture Rose

PRUNUS

P. serotina Ehrh.	**Wild Black Cherry**
P. virginiana L.	Choke Cherry
*P. maritima Wang.	Beach Plum
P. Mahaleb L.	Perfumed Cherry
P. Avium L.	Bird Cherry
P. Cerasus L.	Sour or Morello Cherry
P. persica (L.) Stokes	Peach

LEGUMINOSAE PULSE FAMILY

GLEDITSIA

GLEDITSIA TRIACANTHOS L.	HONEY LOCUST

CYTISUS

*C. triflorus L'Her.	Greek Broom

AMORPHA

*AMORPHA FRUTICOSA L.	FALSE INDIGO

ROBINIA

ROBINIA PSEUDO-ACACIA L.	BLACK LOCUST

RUTACEAE RUE FAMILY

PTELEA

P. TRIFOLIATA L.	HOP TREE

PHELLODENDRON

P. amurense Rupr.	Amoor Cork Tree

SIMARUBACEAE QUASSIA FAMILY

AILANTHUS

A. glandulosa Desf.	Tree of Heaven

ANACARDIACEAE CASHEW FAMILY

RHUS

R. typhina L.	**Staghorn Sumach**
***R. glabra** L.	**Smooth Sumach**
R. copallina L.	**Dwarf Sumach**
R. Vernix L.	Poison Sumach
****R. Toxicodendron** L.	**Poison Ivy**

AQUIFOLIACEAE HOLLY FAMILY

ILEX

I. opaca Ait.	American Holly
***I. verticillata** (L.) Gray	**Black Alder**
*I. glabra (L.) Gray	Inkberry

NEMOPANTHUS

*N. mucronata (L.) Trel.	Mountain Holly

CELASTRACEAE STAFF TREE FAMILY

EVONYMUS

*E. americanus L.	Strawberry Bush

CELASTRUS

****C. scandens** L.	**Climbing Bittersweet**

STAPHYLEACEAE BLADDERNUT FAMILY

STAPHYLEA

*S. trifolia L.	Bladdernut

ACERACEAE MAPLE FAMILY

ACER

A. saccharum Marsh.	Sugar Maple
A. PLATANOIDES L.	NORWAY MAPLE
A. PSEUDOPLATANUS L.	SYCAMORE MAPLE
A. saccharinum L.	Silver Maple
A. rubrum L.	**Red Maple**
A. NEGUNDO L.	BOX ELDER

VITACEAE VINE FAMILY

PARTHENOCISSUS

****P. quinquefolia** Planch.	**Virginia Creeper**

VITIS

****V. Labrusca** L.	**Northern Fox Grape**
****V. aestivalis** Michx.	**Summer Grape**

TILIACEAE LINDEN FAMILY

TILIA

T. americana L.	**Basswood**

CORNACEAE DOGWOOD FAMILY

CORNUS

C. florida L.	**Flowering Dogwood**
***C. Amomum** Mill.	**Kinnikinnik**
*C. stolonifera Michx.	Red Osier Dogwood
*C. paniculata L'Her.	Panicled Dogwood
C. alternifolia L. f.	Alternate-leaved Dogwood

NYSSA

N. sylvatica Marsh.	**Black Gum**

ERICACEAE HEATH FAMILY

CLETHRA

***C. alnifolia** L.	**Sweet Pepperbush**

RHODODENDRON

***R. viscosum** (L.) Torr.	**Clammy Azalea**
***R. nudiflorum** (L.) Torr.	**Pinxter Flower**

KALMIA

K. latifolia L.	**Mountain Laurel**
*K. angustifolia L.	Sheep Laurel

LEUCOTHOE

*L. racemosa (L.) Gray	Fetter Bush

LYONIA

*L. mariana (L.) D. Don	Stagger Bush
*L. ligustrina (L.) DC.	Male Berry

CHAMAEDAPHNE

*C. calyculata Moench	Leather Leaf

EPIGAEA

*E. repens L.	Trailing Arbutus

GAYLUSSACIA

*G. dumosa (Andr.) T. & G.	Dwarf Huckleberry
*G. frondosa (L.) T. & G.	Dangleberry
***G. baccata** (Wang.) C. Koch	**Black Huckleberry**

VACCINIUM

*V. stamineum L.	Deerberry
*V. pennsylvanicum Lam.	Low Sweet Blueberry
***V. vacillans** Kalm.	**Late Low Blueberry**
***V. corymbosum** L.	**High Blueberry**
*V. atrococcum (Gray) Heller	Black High Blueberry
*V. macrocarpon Ait.	American Cranberry

EBENACEAE EBONY FAMILY

DIOSPYROS

D. virginiana L.	Persimmon

OLEACEAE OLIVE FAMILY

FRAXINUS

F. americana L.	**White Ash**
F. pennsylvanica Marsh.	Red Ash
F. nigra Marsh.	Black Ash

SYRINGA

*S. vulgaris L.	Lilac

LIGUSTRUM

*L. vulgare L.	Privet

SOLANACEAE NIGHTSHADE FAMILY

LYCIUM

*L. halimifolium Mill.	Matrimony Vine

SCROPHULARIACEAE FIGWORT FAMILY

PAULOWNIA

P. tomentosa (Thunb.) Steud.	Paulownia

BIGNONIACEAE BIGNONIA FAMILY

TECOMA

**T. RADICANS (L.) Juss.	TRUMPET CREEPER

CATALPA

C. BIGNONIOIDES Walt.	CATALPA

RUBIACEAE MADDER FAMILY

CEPHALANTHUS

***C. occidentalis** L.	**Buttonbush**

CAPRIFOLIACEAE HONEYSUCKLE FAMILY

DIERVILLA

*D. Lonicera Mill.	Bush Honeysuckle

LONICERA

**L. JAPONICA Thunb.	Japanese Honeysuckle
**L. sempervirens L.	Trumpet Honeysuckle

SYMPHORICARPOS

*S. ALBUS Blake	SNOWBERRY

VIBURNUM

***V. acerifolium** L.	**Maple-Leaved Viburnum**
***V. dentatum** L.	**Arrow-Wood**
*V. nudum L.	Smooth Viburnum
V. Lentago L.	Nannyberry
***V.prunifolium** L.	**Black Haw**

SAMBUCUS

***S. canadensis** L.	**Common Elder**

COMPOSITAE COMPOSITE FAMILY

BACCHARIS

***B. halimifolia** L.	**Groundsel Bush**

IVA

***I. oraria** Bartlett	**Marsh Elder**

Arthur Harmount Graves.

his Number completes Series XIII, 1925

BROOKLYN BOTANIC GARDEN

LEAFLETS

Series XIII Brooklyn, N. Y., October 28, 1925 No. 10

SOME QUESTIONS RELATING TO THE CLASSIFICATION OF FLOWERING PLANTS

"A natural classification must be sought diligently. First and last this is desired. Nature does not make sudden transitions. Plants show affinity in all directions, just as territories on a map. System is a thread of Adriadne, without which botany is reduced to chaos," wrote Linnaeus in his *Philosophia Botanica,* 1763.

Jussieu's *Genera Plantarum Secundum Ordines Naturales Disposita,* published in 1789, is generally considered as the first approximation to a natural classification of plants. Bernard and Antoine Laurent de Jussieu brought together good points from Jung, Ray, Tournefort, and Linnaeus; from Jung the abandonment of the old groups of woody and herbaceous plants; from Ray, the adoption of the conception of monocotyledons and dicotyledons; from Tournefort, the emphasis on the character of the corolla; from Linnaeus, his suggestions for grouping genera under "natural orders." Jussieu's main groups were Acotyledones, Monocotyledones, Dicotyledones.

De Candolle improved the limits and arrangement of families; he placed Dicotyledones at the beginning.

Bentham and Hooker modified the system of De Candolle. As in the earlier systems, the idea of "affinity" was now generally recognized, though this did not, to Bentham at least, imply actual common descent or evolution. Their arrangement may be suggested by naming a number of families (usually one in each of Engler's orders). Those which are near together in both the Bentham & Hooker and the Engler systems and which have many characters in common, are connected by double lines.

Dicotyledons

Petals separate: Crowfoot = poppy, pink, St. John's wort = mallow, geranium = buckthorn = maple, rose, myrtle, gourd, cactus, dogwood.

Petals united: Honeysuckle, composite, heath, primrose, ebony, olive = phlox.

Petals absent: Amaranth, pepper, birch, willow.

Monocotyledons

Orchid = lily, palm, cattail, arum, arrowhead, grass.

In the Engler system, which is also much like that of Eichler, the sequence of the above named families is the following:

MONOCOTYLEDONS

Cattail, arrowhead, grass, palm, arum, lily = orchid.

DICOTYLEDONS

Petals absent: Casuarina, pepper, willow, birch, amaranth, pink.

Petals separate: Crowfoot = poppy, rose, geranium = maple = buckthorn, mallow = St. John's wort, cactus, myrtle, dogwood.

Petals united: Heath, primrose, ebony, olive = phlox, honeysuckle, gourd, composite.

Some of the questions suggested by the differences between these standard systems may be indicated:

1. Do the flowering plants (angiosperms) form a natural group? Arber and Parkin have pointed out that angiosperms, the fossil group *Bennettitales,* and *Welwitschia,* are the only plants having the carpels or megasporophylls inserted on the axis above the stamens, or microsporophylls, and having all these subtended by a floral envelope (perianth). It is probable that the earliest insect-pollinated plants had only pollen, not nectar, to attract insect visitors. With the stamens below the carpels, the insects seeking pollen, alighting on the end of the cone, would have to pass by the carpels. If the stamens were above, the carpels might not be touched at all. That is, this arrangement would be almost a necessary one for effective insect pollination. In wind pollinated plants, on the other hand, it is an advantage for cross pollination to have the carpels and stamens in separate flowers or on separate plants.

2. Should a natural classification of angiosperms begin with dicotyledons or monocotyledons? In this connection it may be said that if Bentham and Hooker had included ferns and lower plants in their work, these would doubtless have been placed afterward, at the end. As far as the question can be answered at present, it rather appears that the earliest angiosperms were dicotyledons, and that the monocotyledons are a side branch from early dicotyledons.

3. Have the catkin-bearing trees such as birch ever had insect pollination? If so, their resemblance to the rose groups of families may indicate a real relationship; if not, they may have come directly from gymnosperms, where wind pollination is the rule. In both systems these plants come next to gymnosperms.

4. In the Bentham and Hooker system the pink family is near the St. John's wort group. Engler moved the pink family to near the amaranth family. May not both these relationships be true?

5. Is the poppy family related to the rockrose family as implied in the Bentham and Hooker system?

6. Are the dogwood and honeysuckle families related? With the exception of the honeysuckle and composite families the *sympetalae* are very similarly arranged in the two systems.

7. Does the resemblance between the crowfoot family (Ranunculaceae) and the water-plantain family (Alismaceae) represent a real relationship? If so, how is the early fossil appearance of palms, which are so different, to be explained?

From an earlier LEAFLET (Series XI, No. 9) the probable direction of evolution in flowering plants may be briefly summarized. The capitals indicate the more common characters; for example, united carpels are more common than separate ones.

Stem

WOODY STEM to herbaceous,
scalariform to POROUS VESSELS.

Perianth

spiral to CYCLIC
separate to UNITED SEPALS,
SEPARATE PETALS to united,
REGULAR to irregular.

Stamens

numerous to FEW,
TWO WHORLS to one,
SEPARATE to united.

Carpels

separate to UNITED CARPELS,
MANY CARPELS to few,
SUPERIOR OVARY to inferior,
AXILE PLACENTATION to parietal or central.

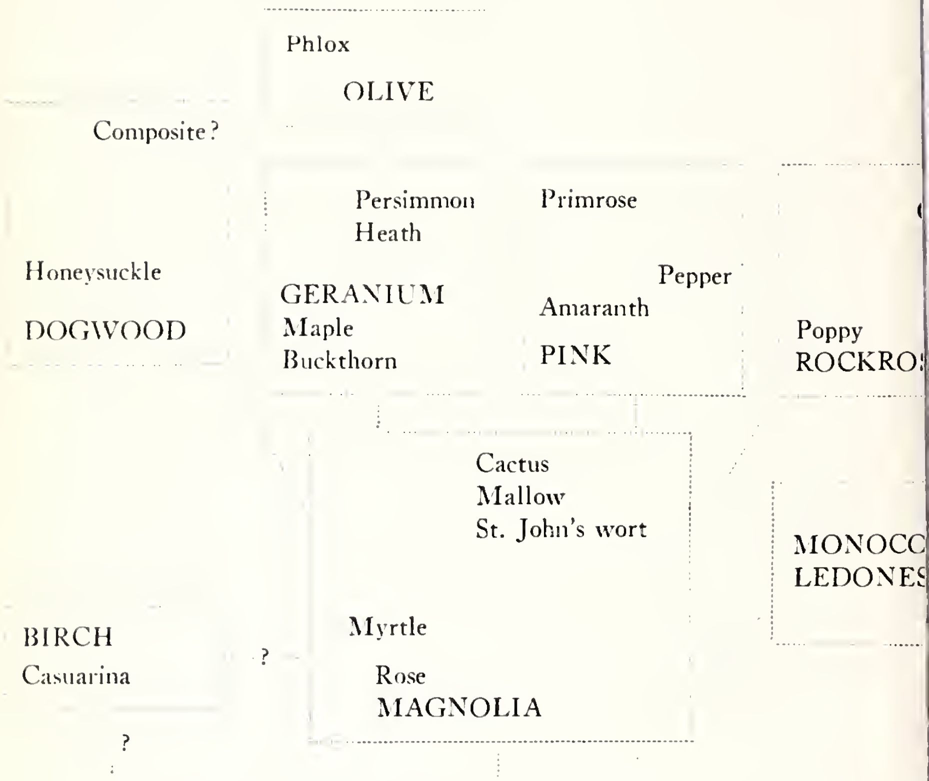
Seed

MANY OVULES to few,
TWO SEED COATS to one,
ENDOSPERM to none,
TWO COTYLEDONS to one.

The course of evolution appears to have proceeded more or less in the form of a tree, or like an inverted cone. At first there were a few, generalized forms, later came many forms, specialized in various directions. The living forms are only the ends of the branches of the tree of evolution. However, some forms have hardly changed in the course of millions of years; for example, the living mollusk *Nautilus* is about the same as the fossils from the earliest Paleozoic era. The gymnosperms are a very ancient group of plants, while angiosperms are comparatively recent. Within the angiosperms, forms like magnolia seem to be very ancient: these have nearly all the left side characters in the above list. Dandelion, with the right side characters, is doubtless a modern type.

The earliest fossil angiosperms have in large part the left side characters. Among the earliest families, from the middle cretaceous, are: beech, walnut, bayberry, willow, magnolia, laurel, planetree, witchhazel, sterculia, ginseng, honeysuckle (viburnum), buckthorn holly, rue, and persimmon. In this list there are many wind-pollinated plants, an absence of herbaceous plants, absence of sympetalous plants (except viburnum and persimmon), absence of plants with central or parietal placentation (except willow).

To compare linear arrangements of forms of life is something like comparing linear arrangements of countries, which in themselves are not arranged in a line. A diagram has at least the advantage that it may exhibit affinity in different directions. The diagram below attempts to indicate the "branching out" of characters of flowering plants.



The prevailing characters common to most, but not all, of the plants within the dotted rectangles may be given in the form of a key:

Wind pollinated . . . . BIRCH GROUP
Insect pollinated
Placentation axile (or carpels separate)
Stamens numerous, carpels often numerous, seed coats 2 . . . . MAGNOLIA GROUP
Stamens in 2 whorls, carpels often 5, seed coats usually 2 . . . . GERANIUM GROUP
Stamens in 1 whorl, carpels usually less than 5, seed coat 1
Ovary superior . . . . OLIVE GROUP
Ovary inferior . . . . DOGWOOD GROUP
Placentation parietal, seed coats usually 2— ROCKROSE GROUP
Placentation central, seed coats 2 . . . . PINK GROUP

Alfred Gundersen.